



UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

## FINAL EXAMINATION

TRIMESTER 3, 2018/2019

**ERT3046 – MACHINE VISION**  
(RE)

29 MAY 2019  
09.00 AM – 11.00 AM  
(2 Hours)

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### INSTRUCTION TO STUDENT

1. This Question Paper consists of 6 pages including cover pages with 4 Questions only.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

## QUESTION 1

a) Briefly explain ONE (1) main factor that influence the formation of an image. [2 marks]

b) A vision system consists of a camera and a lighting system. An image analysis software is to be designed to solve the following tasks:

- to acquire images of smooth dark grey of multiple size nuts.
- to measure the size of the nuts in terms of number of pixels
- to count the number of nuts in each image captured.

Propose the specifications of the system with respect to the following subsystem and elaborate on your choice:

(i) Camera: monochrome or color? [3 marks]

(ii) Lighting system: front lighting or backlighting? [3 marks]

(iii) Image Analysis: What are the steps that should be taken to be able to measure size and number of the nuts including any image preprocessing if required? [6 marks]

c) One of the popular methods to enhance the quality of an image is by using a *median* filter.

(i) What is the principle function of a median filtering? Describe how median filter can achieve this objective. [3 marks]

(ii) What will be the result be if a 3 x 3 medial filter is applied to the image in **Figure Q1a**. Note that the image is already zero-padded. [8 marks]

0	0	0	0	0	0	0
0	2	3	5	0	3	0
0	3	1	8	4	7	0
0	8	2	0	6	9	0
0	9	1	3	8	9	0
0	4	6	3	5	7	0
0	0	0	0	0	0	0

**Figure Q1a**

**Continued ...**

## QUESTION 2

a) Describe TWO areas of applications which use a binary algorithms analysis. [4 marks]

b) Figure Q2a shows a binary image in which an object is marked by a pixel 1.

1	1	0	1	1	1	0	1
1	1	0	1	0	1	0	1
0	0	0	1	1	1	0	1
0	0	0	0	0	0	0	1
1	1	1	1	0	1	0	1
0	0	0	1	0	1	0	1
0	1	0	1	0	0	0	1
0	1	1	1	0	1	1	1

Figure Q2a

Solve the following questions:

(i) Find all connected components and assigns a unique label to all points in the same component. Shows intermediate steps and equivalence table if any. [6 marks]

(ii) Find number of foreground object, background and holes if 4-connectivity scheme is applied. [6 marks]

(iii) What will be the output image if a size filter of  $T = 10$  pixels is applied to the image? [3 marks]

c) Write down the quad tree for the following image in Figure Q2b. [6 marks]

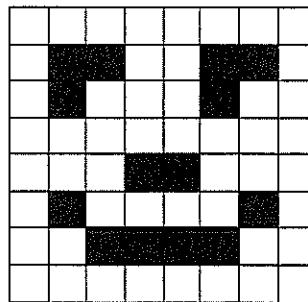


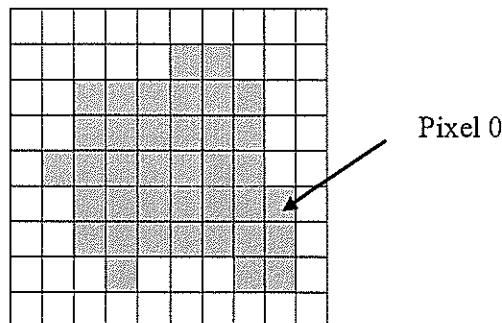
Figure Q2b

Continued ...

### QUESTION 3

a) A contour of an image may be represented as an ordered list of edges or by a curve. Describe TWO main criteria of a good contour representation. [4 marks]

b) **Figure Q3a** shows a binary image containing an object represented by the darker pixels.



**Figure Q3a**

(i) Extract the *boundary* of the object and redraw it in a separate image. [3 marks]

(ii) From the resultant boundary image of Question 3(a)(i), extract the 8-direction chain code of the contour starting from location marked as Pixel 0 and measured in counter-clockwise direction. [5 marks]

(iii) Analyze the resultant boundary image of Question 3(a)(i) and produce the difference code of the contour (assume circular sequence). [5 marks]

c) The following image in **Figure Q3b** contains a texture with three different gray levels (0, 1, and 2):

(i) Write down the gray-level co-occurrence matrix for the displacement vector (1, 1). [4 marks]

(ii) Imagine that you had a very large image with completely randomly distributed gray values 0, 1, and 2. Each of the 3 values appears equally often. Write down the cooccurrence matrix for the displacement vector (1, 1) that you would expect. [4 marks]

**Continued ...**

0	1	2	0	1	2	0
0	1	2	0	1	2	0
2	0	1	2	0	1	2
2	0	1	2	0	1	2
1	2	0	1	2	0	1
1	2	0	1	2	0	1
0	1	2	0	1	2	0

**Figure Q3b****QUESTION 4**

a) A video camera is used to capture a moving object. **Figure Q4a(i)** shows the video sequence at frame  $t = 5$  seconds and **Figure Q4a(ii)** at frame  $t = 6$  seconds. Determine the difference image for the sequence. [6 marks]

3	4	4	4	1	2	1
2	21	22	31	22	3	4
3	13	14	13	2	1	3
2	12	15	30	21	2	4
1	14	32	30	24	2	3
3	15	32	31	25	1	2
4	1	5	6	2	1	4

**Figure Q4a(i)**

3	4	4	4	1	2	1
2	3	21	22	31	3	4
3	4	13	14	13	1	3
2	3	12	15	30	21	4
1	2	14	32	30	24	3
3	3	15	32	31	1	2
4	1	5	6	2	1	4

**Figure Q4a(ii)****Continued ...**

b) **Table Q4** shows a confusion matrix for a character recognition process attempting to classify characters from 'A' to 'E'. Altogether, there are 500 feature vectors used to represent 500 characters with equal distributions for all classes. 'R' indicates 'reject' class. The empirical reject rate for the test is 4% and the classification error for class 'A' is 47/49.

**Table Q4**  
Classification results

	'A'	'B'	'C'	'D'	'E'	'R'
'A'	X	Y	0	0	0	Z
'B'	0	98	1	1	0	0
'C'	0	2	96	2	0	0
'D'	0	2	0	97	1	0
'E'	0	1	1	1	97	0

Answer the following questions:

- (i) Define the terms *Reject Class* and *Empirical Error Rate*. [4 marks]
- (ii) Determine the number of inputs labeled as 'C' which are misclassified as 'B'. [2 marks]
- (iii) Referring to **Table Q4**, determine the values for X, Y and Z. [3 x 2 marks]
- (iv) Classifier for character 'B' is *less precise* than classifier for character 'C'. What information would you use to support the view? [3 marks]
- (v) Suppose that the value of X is equivalent to 0. Based on your understanding, what conclusion can you make about the classifier, and what changes would you make to rectify the problem? [4 marks]

**End of Paper.**